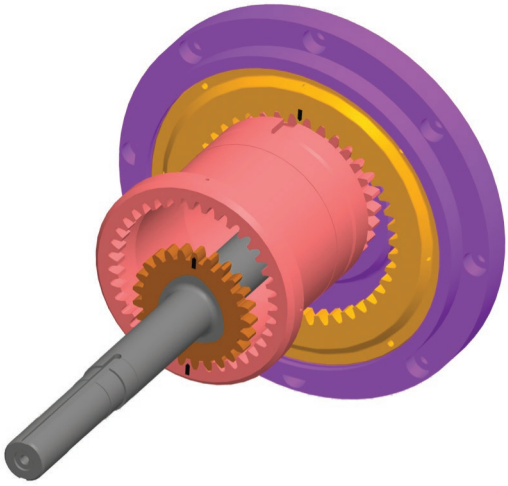
National Aeronautics and Space Administration

technology opportunity

Offset Compound Gear Inline Two-Speed Drive

A significant advancement in multispeed gear drives



NASA illustration

Scientists at NASA's Glenn Research Center have developed a simple, lightweight, inline two-speed drive that can be used either as an overall transmission or as a supplemental add-on input transmission (i.e., overdrive or underdrive) for rotary-wing aircraft and other applications benefiting from variable-speed transmission. This Offset Compound Gear (OCG) extends the range of capability of existing transmissions for aerospace and industrial applications.

Benefits

- **Streamlined:** Features reduced gear and bearing count compared with a conventional simple planetary gear train of equivalent ratio.
- **Simplified:** Offers intermediate gears and bearings that spin at a significantly lower speed compared with planet gears in a conventional planetary gear train of equivalent ratio.
- **Low maintenance:** Requires fewer direct lubrication points to provide gear mesh lubrication and cooling as well as requiring fewer points for bearing lubrication.
- **Lightweight:** Offers compact and simplified construction compared to planetary gear trains.
- **Robust:** Eliminates reversed tooth bending, common to planet gears in planetary gear trains, thereby extending intermediate gear life.
- **Versatile:** Includes a basic configuration that can be used singly or coupled in series to achieve multiple ratios, or to increase the overall ratio, and can also incorporate multiple output shafts at different speeds for low-speed applications requiring such.

Applications

- Aerospace —Advanced rotary wing aircraft
- Industrial uses —High-speed or low-speed drives with multiple-geared ratio-driven outputs

Licensing and Partnering Opportunities

This technology is part of NASA's Technology Transfer Program, which seeks to transfer technology into and out of NASA to benefit the space program and U.S. industry. NASA invites companies to consider licensing the Offset Compound Gear Inline Two-Speed Drive (LEW-18340-1) for commercial purposes.

For More Information

For more information about this and other technology licensing opportunities, please contact:

Technology Transfer Office
NASA Glenn Research Center
E-mail: ttp@grc.nasa.gov
Phone: 216-433-3484
http://technology.grc.nasa.gov

Technology Details

How It Works

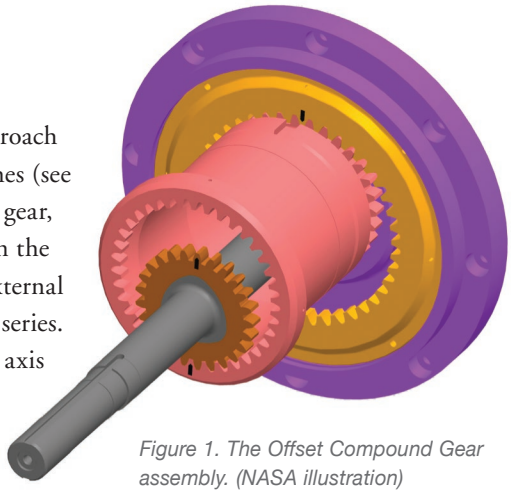


Figure 1. The Offset Compound Gear assembly. (NASA illustration)

The OCG innovation is based on NASA Glenn's novel approach to offsetting the axis of rotations and embedding gear meshes (see Figure 1). The heart of the concept is the offset compound gear, which uses internal teeth on the input and external teeth on the output end, thus allowing it to mesh with both a smaller external tooth input gear and a larger internal tooth output gear, in series. Within this geometry, the cluster gear rotates on a separate axis that is offset from the input gear and output gear, which are located on the machine axis (see Figure 2). The OCG provides a 50 percent speed reduction in two stages, or meshes, utilizing only three gears (the cluster gear replacing the six planet gears required in a simple planetary stage). During high-range operation, the main clutch is engaged, and the output shaft spins at a 1:1 ratio. During low-range operation, the main clutch is disengaged, directing power through the OCG gear train and low-speed sprag (one-way clutch), resulting in an output ratio of 1:2, or a 50 percent speed reduction.

The OCG innovation offers the simplicity of a parallel shaft system along with the highly applicable design of an inline device, like a planetary drive. Other ratios beyond the basic configuration of the OCG can be constructed, enabling application at higher or lower speeds.

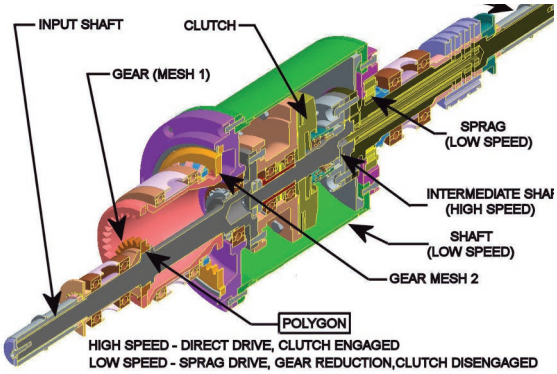


Figure 2. The original OCG configuration. The technology also can be configured as a multistage gear arrangement, enabling shifting between varying speed ratios. (NASA illustration)

Why It Is Better

Conceived in response to a technical void, NASA Glenn's OCG innovation is intended to fill the need for a simple and robust inline two/variable-speed drive transmission capable of a 50 percent speed ratio change. It is lightweight yet capable of transferring high power levels at high speeds for next-generation rotary-wing aircraft and other applications requiring variable-speed propulsion.

Propulsion systems for rotorcraft (or rotary-wing aircraft) are critical to their overall performance. Unlike fixed-wing aircraft, the rotorcraft rotor/propulsion system must provide vehicle lift and control as well as forward thrust. Thus, the rotorcraft engine/gearbox system must be highly reliable, efficient, and lightweight. Future rotorcraft trends call for more versatile, efficient, and powerful aircraft, all of which challenge the current state of the art for propulsion system technologies.

Variable-speed rotors have been identified as having a significant impact on many critical rotorcraft issues. A recent NASA study has shown that variable-speed propulsion is necessary for all aircraft concepts studied and also suggested that speed variations of 50 percent will have a dramatic effect on reducing external noise while increasing performance. Current technologies are capable of varying rotor speed by only a small percentage. This is achieved by adjusting engine speed but is generally limited by engine efficiency and stall margin, resulting in a maximum available range of only 15 percent.

Patent

Glenn has received patent protection for this technology: U.S. Patent Nos. 8,091,445 and 8,668,613.